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Summary study of the shale oil works at Närkes Kvarntorp.

The works of Svenska Skifferoljeaktiebolaget in south-eastern Närke are situated just north of the actual shale desposits. Appendix 1 shows the location of these deposits. The full thickness of the stratum of shale is about 15 meters (approx. 50 feet), and it has a slope of 8 ‰. That means that a triangular strip of land is obtained towards the north which is not covered with limestone. Thus after removal of the earth the shale can be surface-quarried here. Further to the south the shale is covered with limestone and the stratum becomes progressively thicker further south (see appendix 2).

The distillation of the shale is effected in the manner shown in appendix 3. The shale is heated without access of air, either in the furnace or directly in the ground (the Ljungström method). Oil-bearing gases are generated thereby and these are then cooled down in condenser plants to the temperature of the refrigerant by means of water or air. At this juncture the hydrocarbons (from pentane upwards), which are liquid at normal pressure and temperature, are converted into liquid. The non-condensable gas contains about 20 % of sulphurated hydrogen, which is removed in special sulphur plants, where elementary sulphur is produced. The gas still holds some light gasoline. This is washed out by means of a cold and heavier oil in a so-called light gasoline plant built next to the sulphur plant.

The gas free from gasoline and sulphurated hydrogen then flows, partly to certain furnaces, in order to generate by its combustion sufficient heat for the disstillation, partly to the steam plant for steam generation, and finally to the town of Örebro as a substitute for coal gas.

The shale to be treated in the furnaces is surface-quarried by blasting, loaded by excavators onto 8 ton trucks, and transported to the heavy-crusher plant consisting of one big Blakes crusher of Morgårdshammar's design and one roller crusher. The heavy-crushed shale passes via a belt conveyor and a screen to a separating house, where concretions of bituminous lime-stone accompanying the shale are picked by hand. The shale is then crushed down to its final granulation in two hammer crushers of F. L.

Smidth's design. The shale crushed in these machines is transported by a belt conveyor to a screening plant, located on the *top* of silos, and there assorted into three different sizes:

1) > 30 mm for the IM and Rockesholm furnaces
2) 30—5 mm for the Bergh furnaces
3) < 5 mm for nodulisation for distillation in one of the IM furnaces.

From the silos, which have a total capacity of 10,000 tons, the shale is transported to the various furnaces.

Besides the Ljungström procedure three different furnace systems are used:

1) *The Bergh system* (see appendix 4).

There are three furnaces two of which are calculated for a daily charge of shale of approx. 450 tons each and one for approx. 675 tons.

Each one of the small furnaces contains 1,120 retorts approx. 2 meters in height and with an internal diameter of 0,2 meters. The big furnace contains 1.680 retorts of about the same size.

The shale passes through the retort, where it is heated to pyrolysis temperature, with the result that oil-bearing gases are generated, which are sucked out through a pipe placed in the center of the retort. The remaining coke falls down onto a grate, where it is burnt. The combustion gases pass out of the retort, via steam boilers heated by combustion gas to the chimney. In this way the contents of the retort receives directly the surplus heat required for the process.

The ash is fed on belt conveyors and from there via an ash bin to the cable way and dump.

2) *The Rockesholm system* (the Hultman- Gustafsson furnace) (see appendix 5).

This furnace is designed for a daily charge of 500 tons and consists of 72 retorts, each approx. 9 meters in height and 0.7 meters in diameter.

The shale is heated while passing through the retort and the generated pyrolysis gases are sucked out directly to a condenser plant. The coke produced is not burnt, but presently passes via a labyrinth to a quenching device, where it is soaked with water before being transported to the dump.

Around each retort there is a combustion chamber, in the lower part of which gas burners are located for combustion of non-condensable gas, which gives the heat necessary for the process.

3) *The Industrimetoder system* (see appendix 6).

In the Kvarntorp works there are two such furnaces, each one designed for a daily charge of 600 tons. The furnace consists of a long tunnel through which cars loaded with shale pass. At each

furnace there are three fire places, where non-condensable gas is burnt. The hot flue gases then pass through a bundle of pipes running along the tunnel. The flue gases give off their heat to the shale cars, but do not get in contact with the furnace atmosphere. The pyrolysis gases are sucked out in the usual way to the condenser plant. The coke is not burnt, but, as in the Rockesholm process, is first quenched in water before being transported to the dump. A coke combustion plant for the Rockesholm and IM coke is being designed and is expected to be ready by the middle of next year. Part of the breeze obtained is subjected to the so-called nodulisation. After grinding the shale breeze to shale powder, breeze, powder and water are mixed in a special plant. The mixture is then passed through drums in which balls are formed. These balls are then dried by means of flue gases and are charged into cars, which then pass through one of the IM furnaces.

4) *The Ljungström system* (see appendix 7).

When this method is used the shale is not quarried and as a matter of fact the method can be carried through with the best result in an area, covered with limestone. The whole field to be treated is divided into hexagons with sides of 2.2 meters. In the corners of the hexagons holes are drilled through the strata of earth, limestone and shale. In these holes iron tubes are inserted. An electrical rsistance is built into the iron-tube and insulated by means of quartz-sand from the tube. Electric current is switched on, and the shale is heated. In the centre of the hexagon a hole has been drilled, into which the generated oil gases will flow. The oil gases are collected by means of a tube system and conducted to a condenser plant.

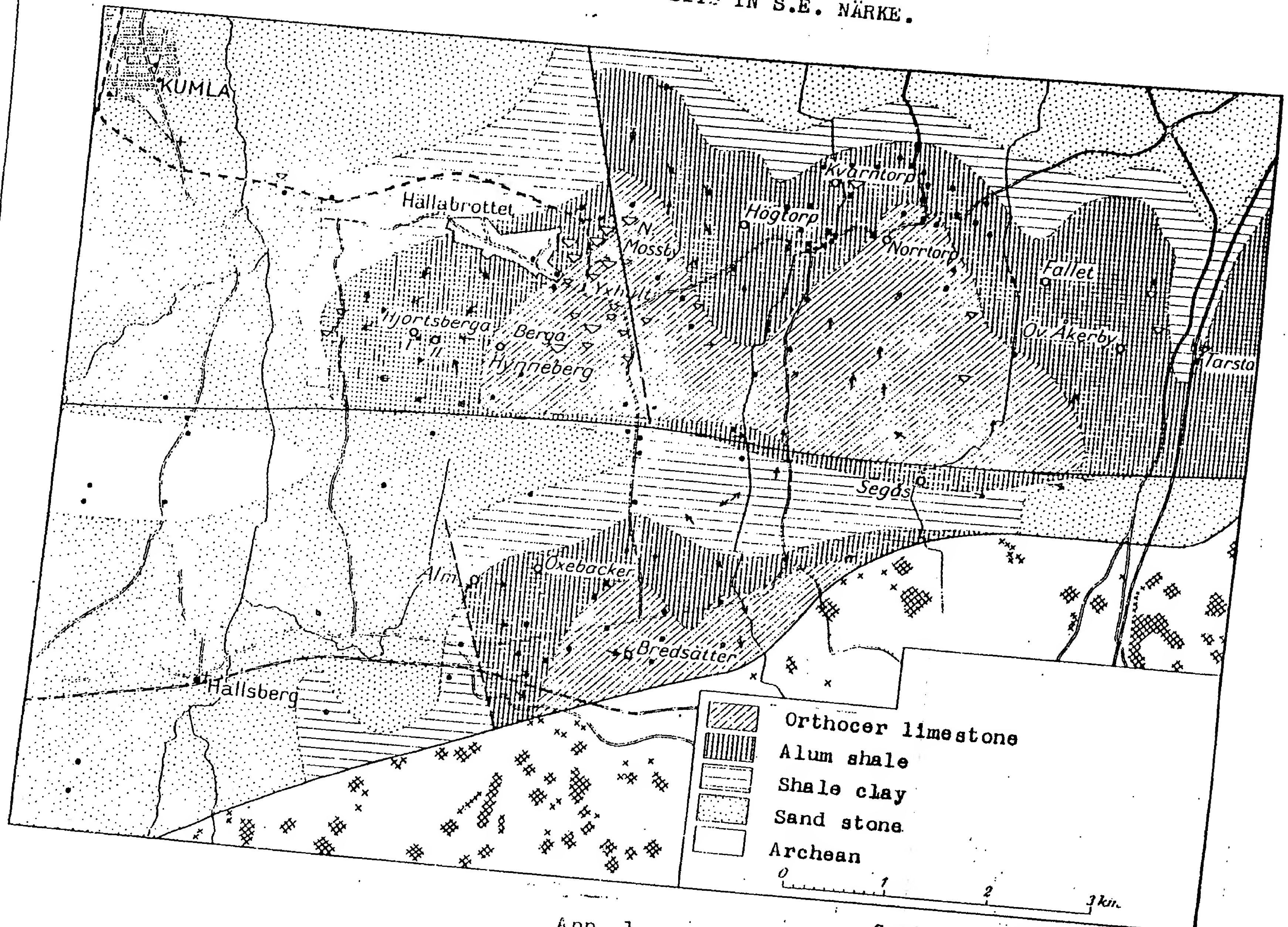
When the oil fractions have been condensed, they are pumped into crude oil tanks. The crude oil then passes through a so-called topping plant, where gasoline and kerosene are separated from the heavier fuel oil. Gasoline and kerosene fractions are subjected to refinement with subsequent fractional destillation.

A chart showing the oil production in principle is found in appendix 8, where the quantities now being produced annually at Kvarntorp are also given.

Appendix 9 shows in principle the disposition of the noncondensable gases. The figures given in the chart refer in this case to the daily production.

Appendix 10 is as corresponding chart for the steam production. It has been assumed that the above mentioned coke combustion plant has been put in operation. In this case also the figures giving the quantities refer to the daily production.

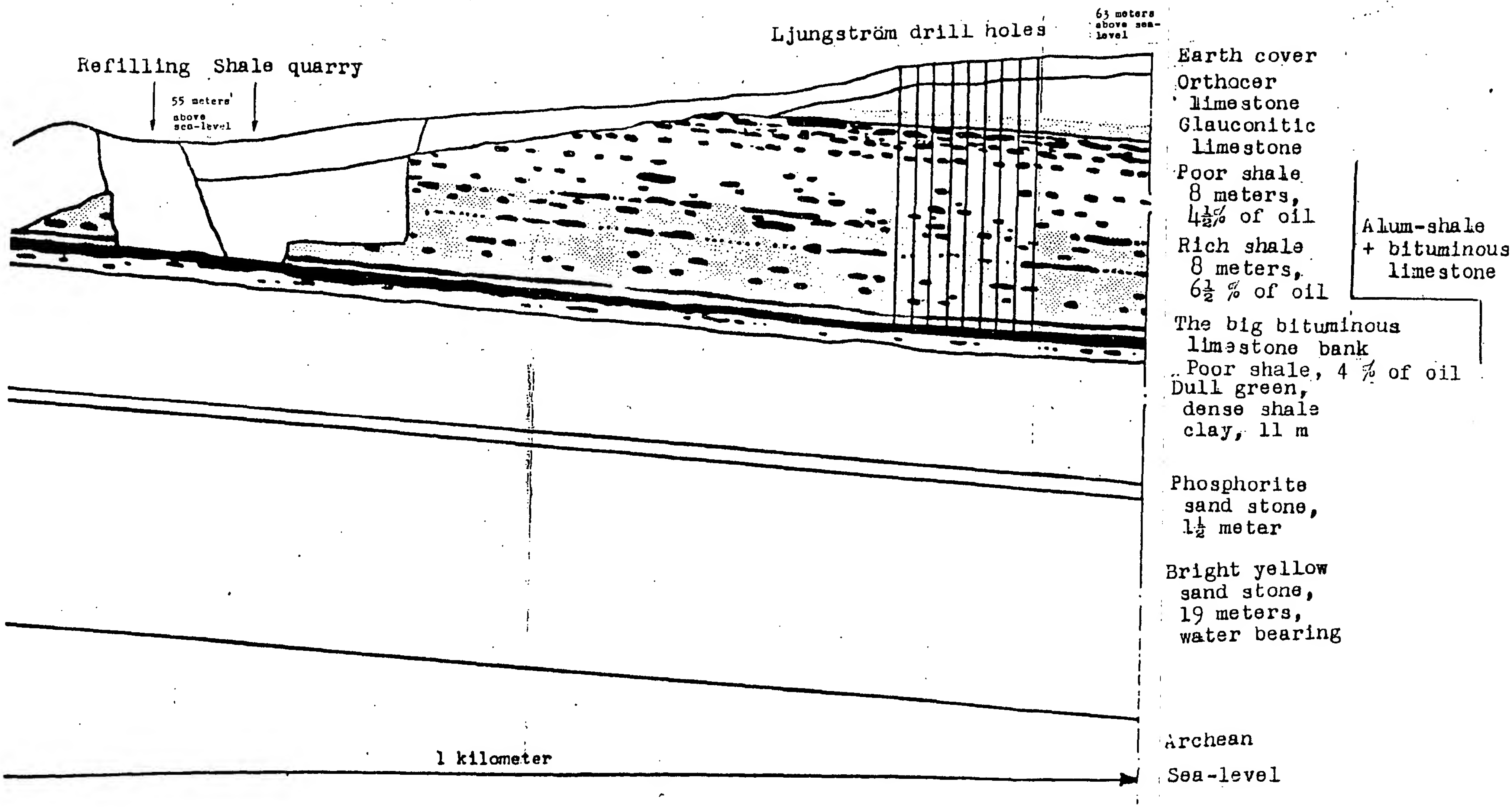
MAP OF SHALE DEPOSITS IN S.E. NÄRKE.



App. 1

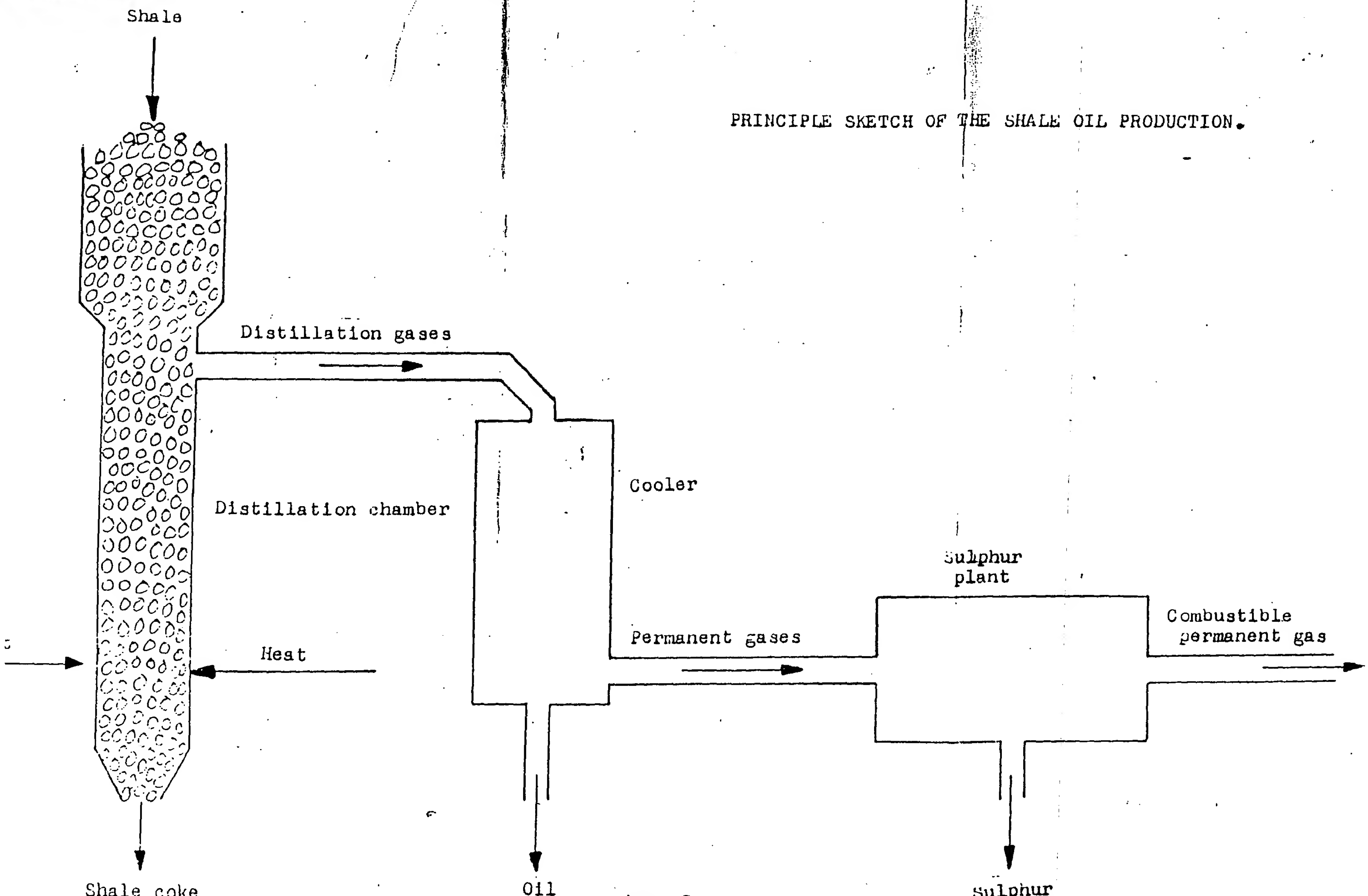
Scale 1:50.000

VERTICAL SECTION THROUGH THE SHALE DEPOSIT AT KVARNTORP.

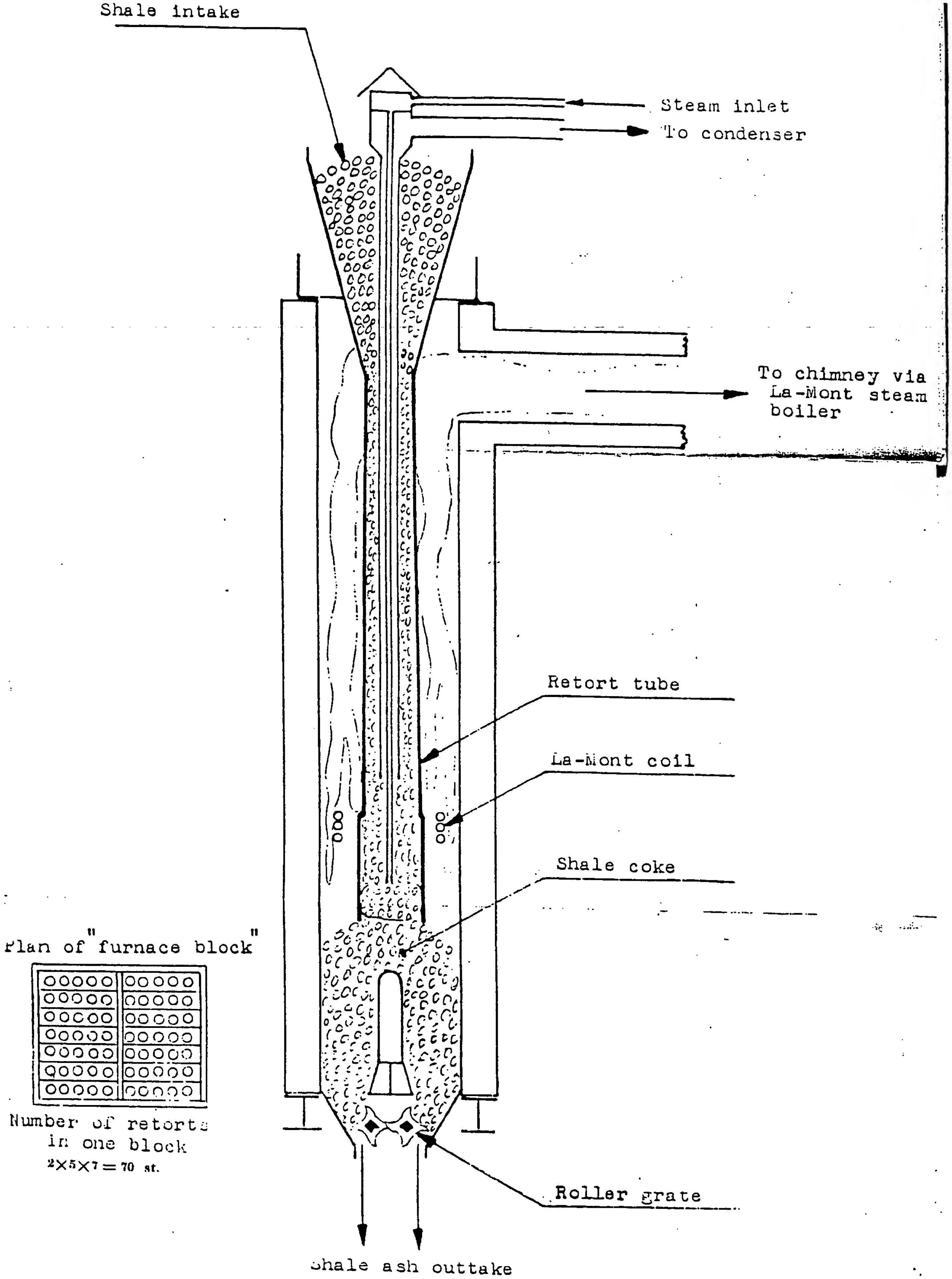


App. 2

PRINCIPLE SKETCH OF THE SHALE OIL PRODUCTION.

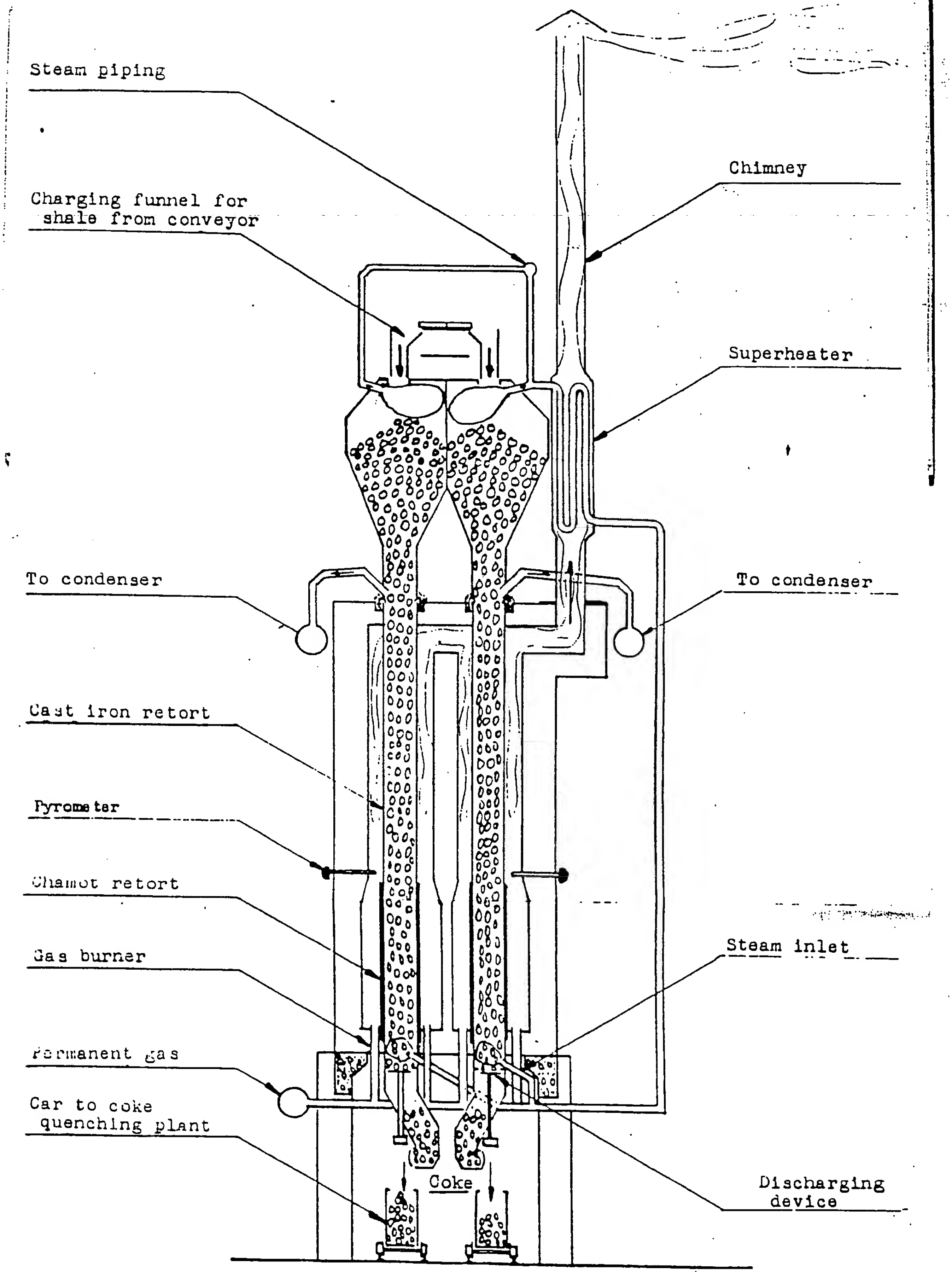


App. 3

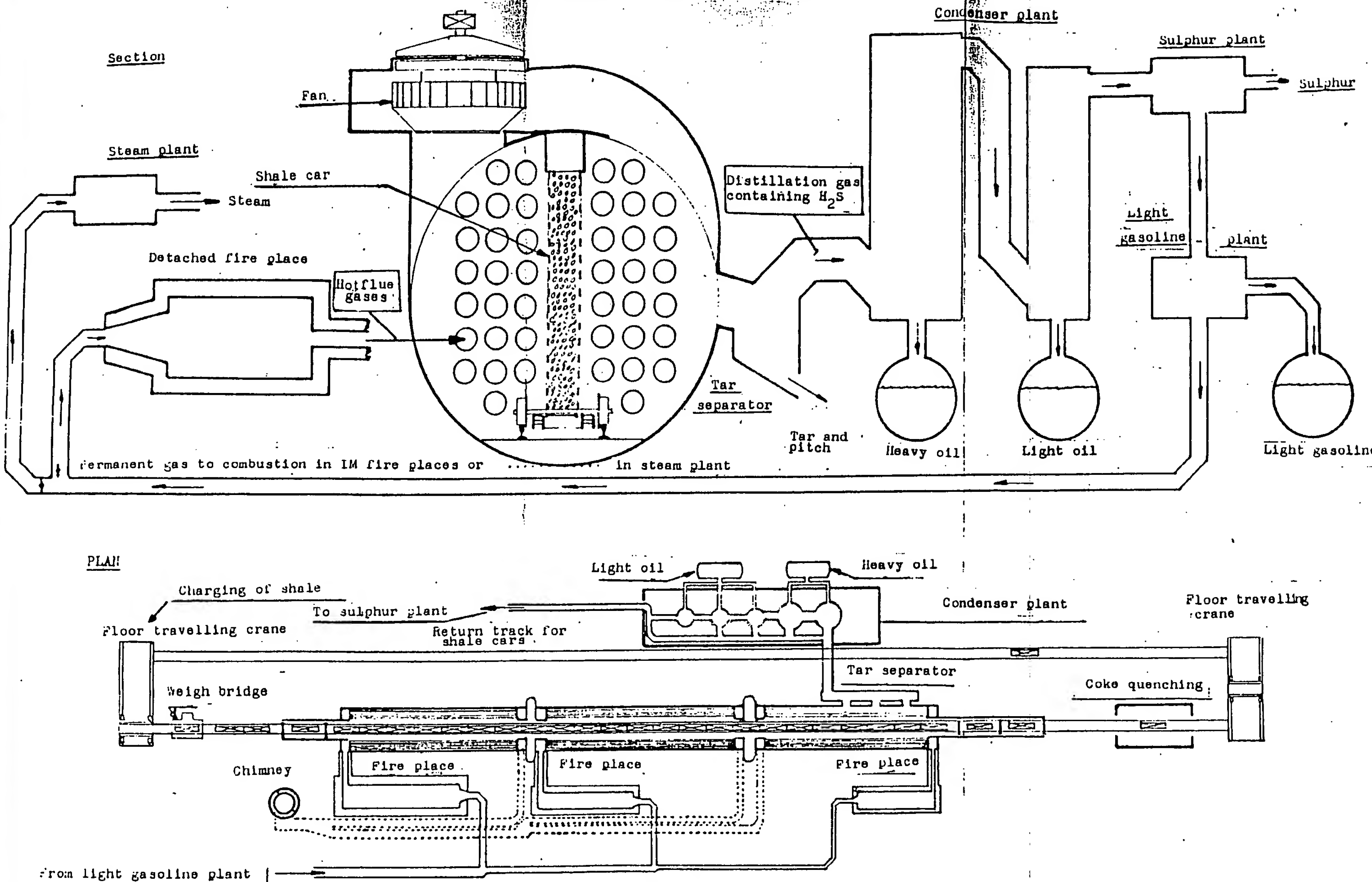

Shale intake
Steam inlet
To condenser
To chimney via La-Mont steam boiler
Retort tube
La-Mont coil
Shale coke
Plan of "furnace block"
Number of retorts in one block
2×5×7 = 70 st.
Roller grate
Shale ash outtake

App. 4

THE ROCKESHOLM SYSTEM.

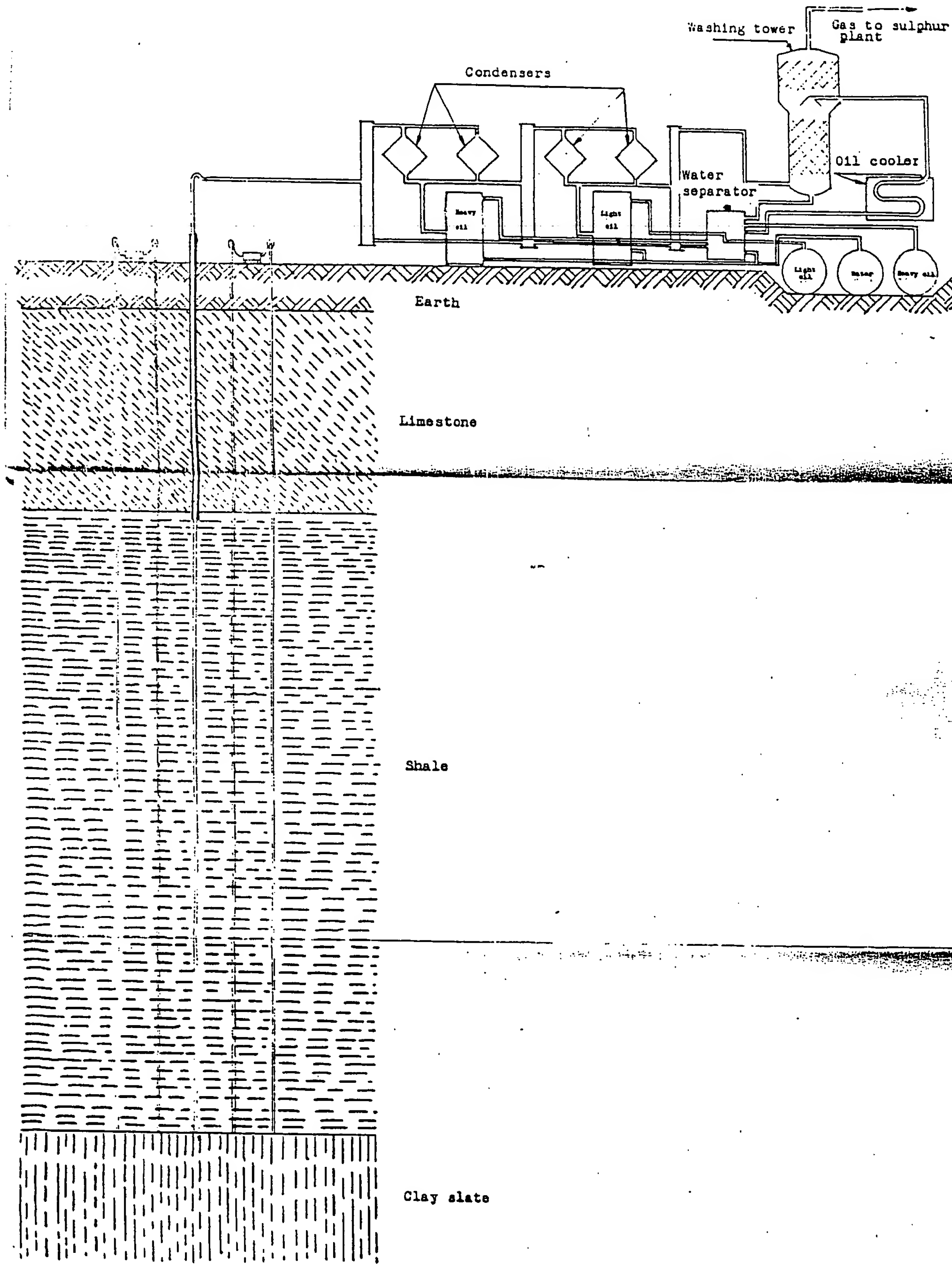


THE INDUSTRIMETODER SYSTEM (IM).



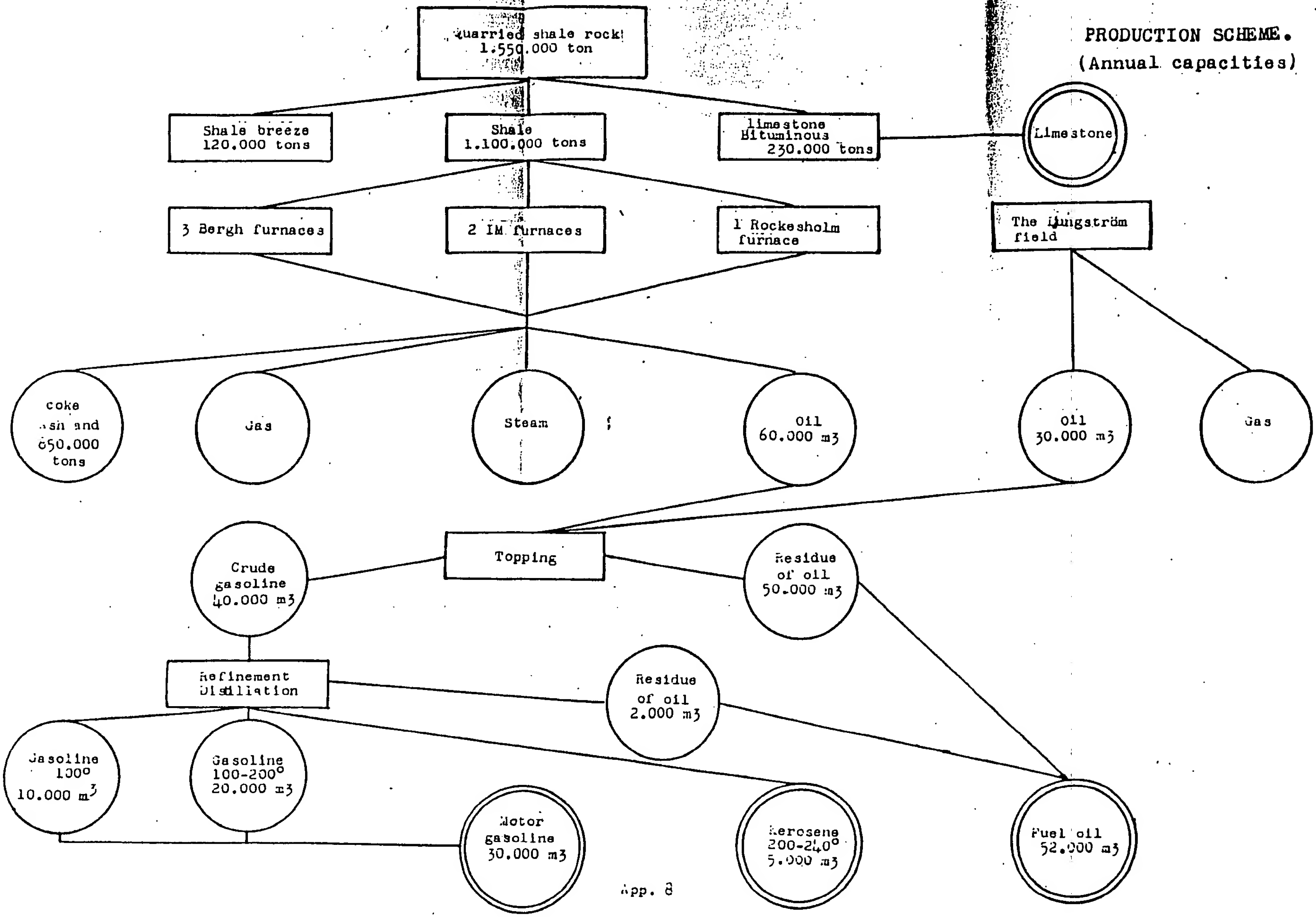
App. 6

THE LJUNGSTRÖM SYSTEM.



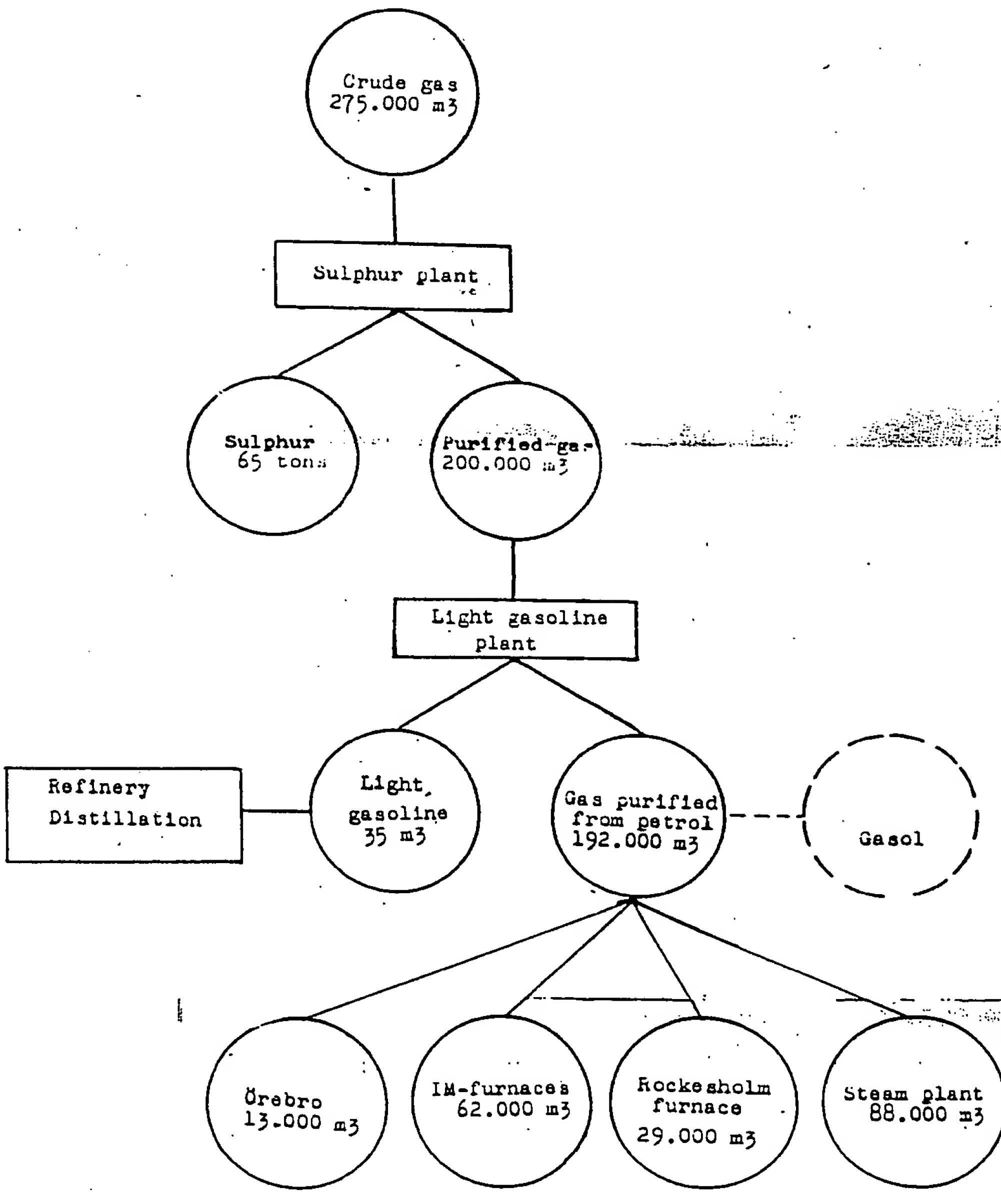
PRODUCTION SCHEME.

(Annual capacities)



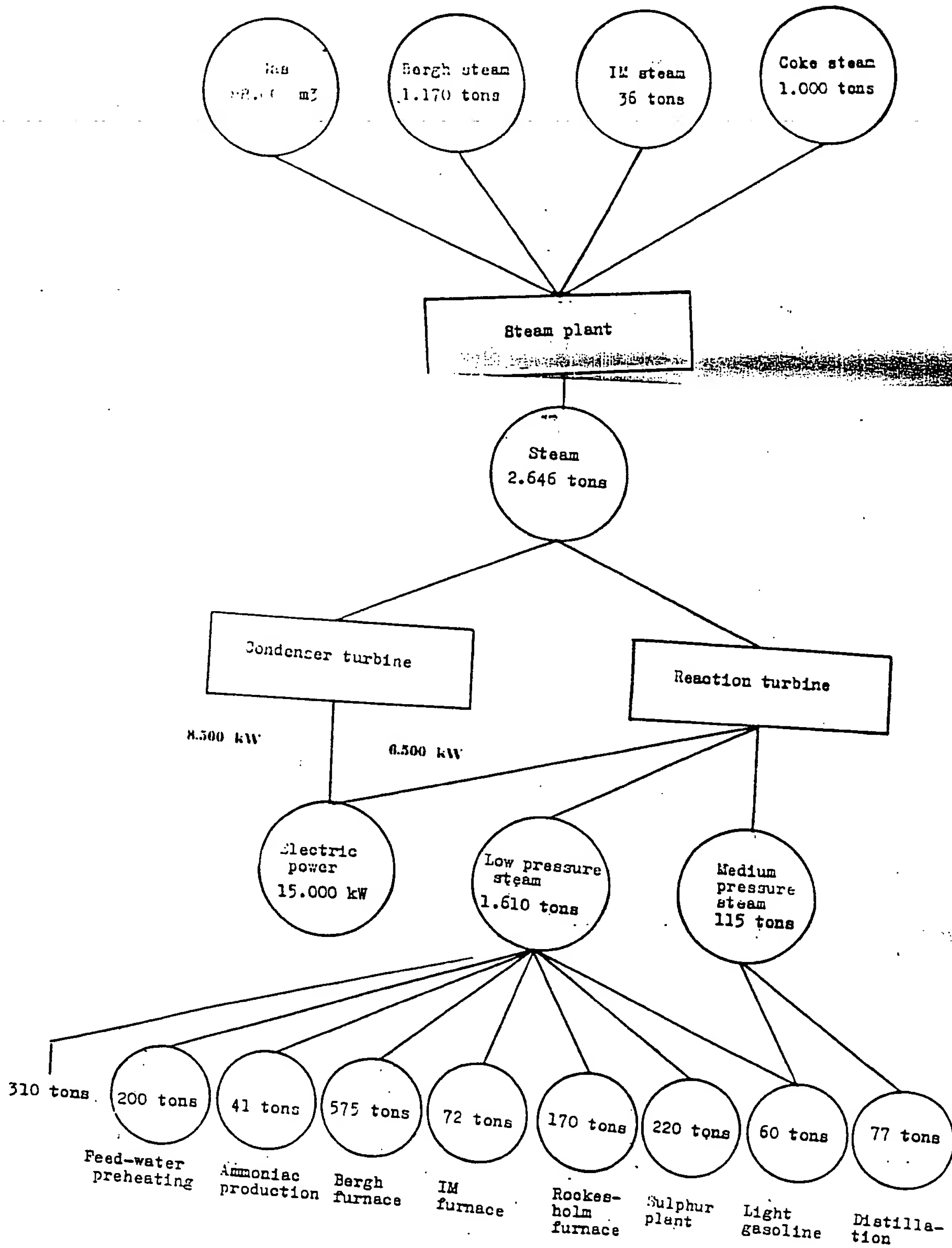
App. 8

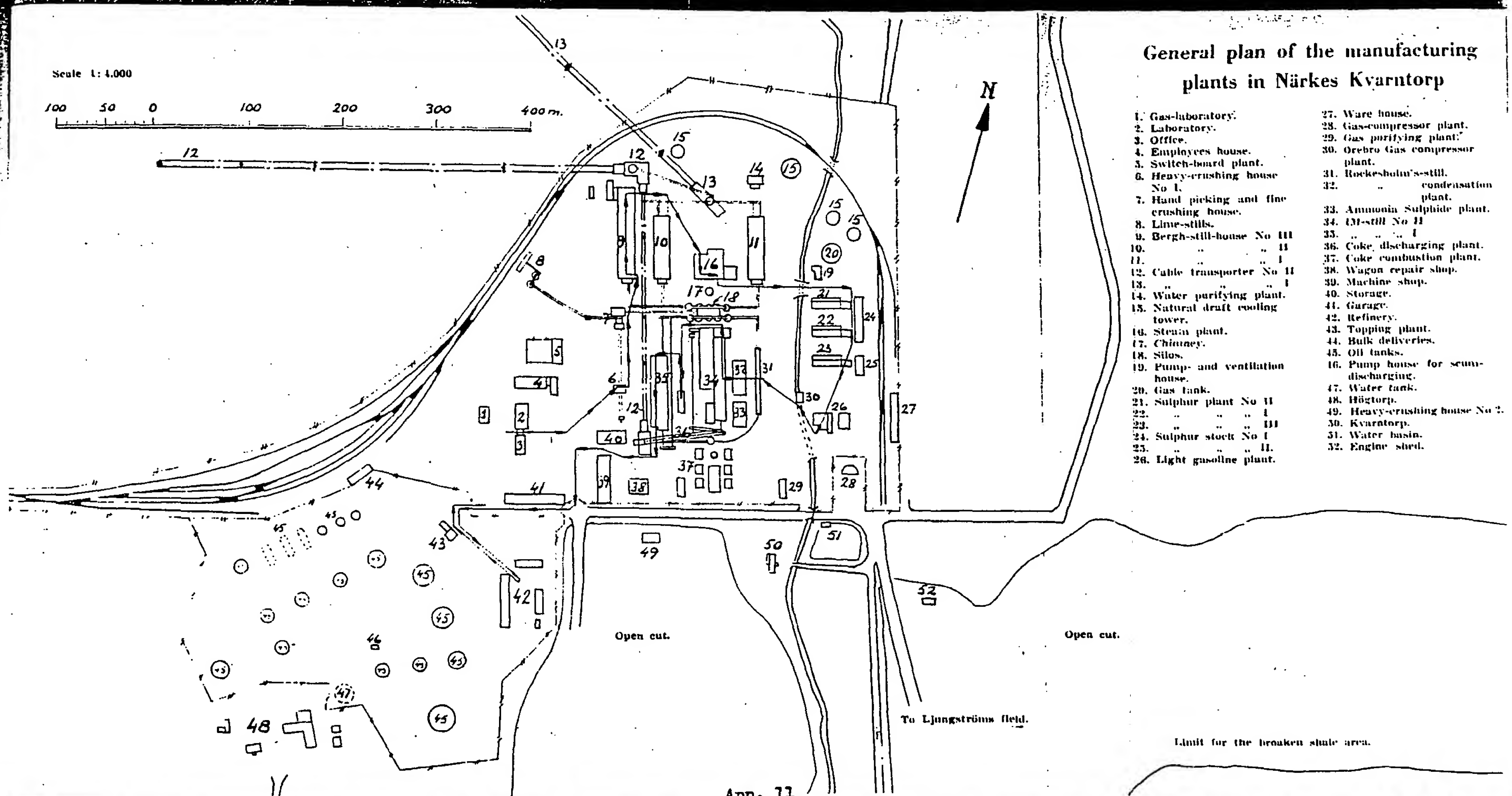
GAS SCHEME.
(Daily capacities)



STEAM SCHEDULE.

(Quantities given per day)





General plan of the manufacturing plants in Närkes Kvarntorp

1. Gas-laboratory.
2. Laboratory.
3. Office.
4. Employees house.
5. Switch-board plant.
6. Heavy-crushing house No I.
7. Hand picking and fine crushing house.
8. Lime-stills.
9. Bergh-still-house No III
10. " " II
11. " " I
12. Cable transporter No II
13. " " I
14. Water purifying plant.
15. Natural draft cooling tower.
16. Steam plant.
17. Chimney.
18. Silos.
19. Pump- and ventilation house.
20. Gas tank.
21. Sulphur plant No II
22. " " I
23. " " III
24. Sulphur stock No I
25. " " II.
26. Light gasoline plant.
27. Ware house.
28. Gas-compressor plant.
29. Gas purifying plant.
30. Orebro Gas compressor plant.
31. Rockesholm's-still.
32. " condensation plant.
33. Ammonia Sulphide plant.
34. Oil-still No II
35. " " I
36. Coke discharging plant.
37. Coke combustion plant.
38. Wagon repair shop.
39. Machine shop.
40. Storage.
41. Garage.
42. Refinery.
43. Topping plant.
44. Bulk deliveries.
45. Oil tanks.
46. Pump house for scum-discharging.
47. Water tank.
48. Högtorp.
49. Heavy-crushing house No 2.
50. Kvarntorp.
51. Water basin.
52. Engine shed.

App. 11